US 20140206407A1

(19) United States

(12) Patent Application Publication

(10) Pub. No.: US 2014/0206407 A1

(43) Pub. Date: Jul. 24, 2014

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(54) METHOD AND DEVICE FOR DISCOVERING NEIGHBORS FOR WIRELESS FIDELITY DIRECT (WFD) PEER TO PEER (P2P) COMMUNICATION

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(21) Appl. No.: **14/241,299**

(22) PCT Filed: **Aug. 27, 2012**

(86) PCT No.: **PCT/KR2012/006820**

§ 371 (c)(1),
(2), (4) Date: **Feb. 26, 2014**

Related U.S. Application Data

(60) Provisional application No. 61/527,618, filed on Aug. 26, 2011.

Publication Classification

(51) **Int. Cl.**
H04W 8/00 (2006.01)

(52) **U.S. Cl.**
CPC *H04W 8/005* (2013.01)
USPC **455/515**

(57) **ABSTRACT**

The present invention relates to a wireless communication system. In particular, the present invention relates to a method and device for performing the process of discovering neighbors for Wi-Fi P2P communication, the method including the steps of: checking at a first WFD P2P device whether there is WFD P2P group in which participation is possible; performing, at the first WFD P2P device, the operation for participating in the WFD P2P group in which participation is possible, if there is a WFD P2P group in which participation is possible, or performing, at the first WFD P2P device, the operation for creating a new WFD P2P group or entering a sleep mode, if there is no WFD P2P group in which participation is possible, wherein the operation for participating in the WFD P2P group in which participation is possible includes the steps of receiving information about a neighbor list on a second WFD P2P device (or devices) within the WFD P2P group from a specific WFD P2P device that manages the WFD P2P group, and periodically transferring neighbor advertisement information on the first WFD P2P device to the specific WFD P2P device, after receiving the neighbor list.

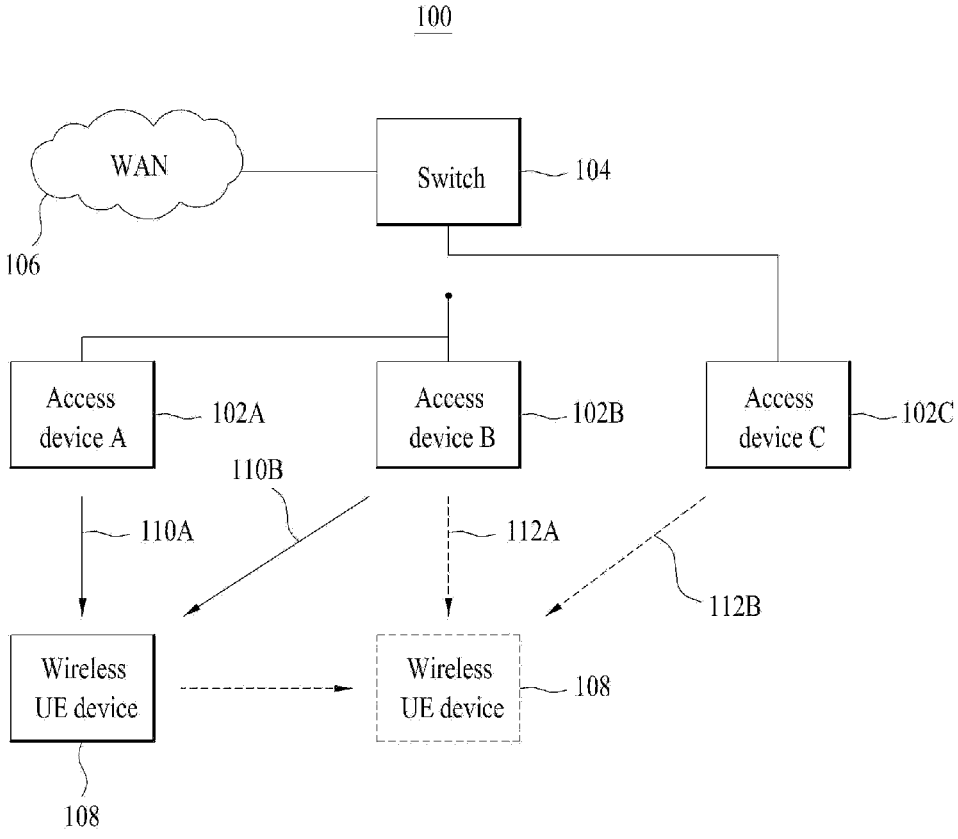


FIG. 1A

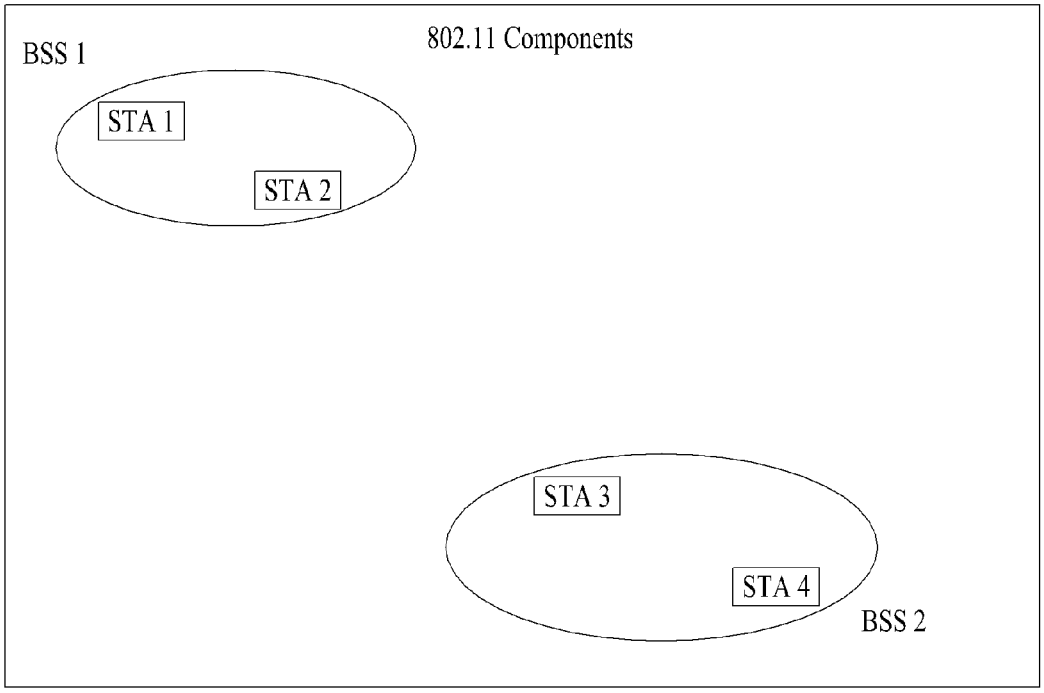


FIG. 1B

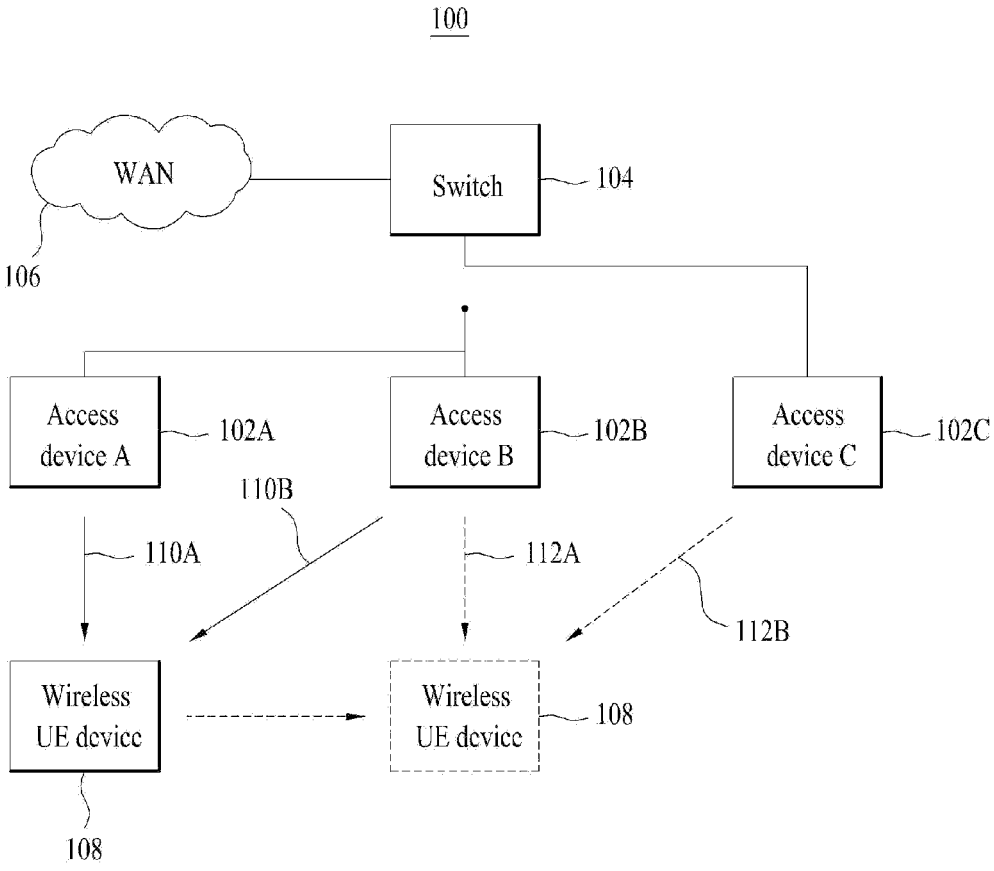

100
WAN
106
Switch
104
Access device A
102A
Access device B
102B
Access device C
102C
110B
110A
112A
112B
Wireless UE device
108
Wireless UE device
108

FIG. 2

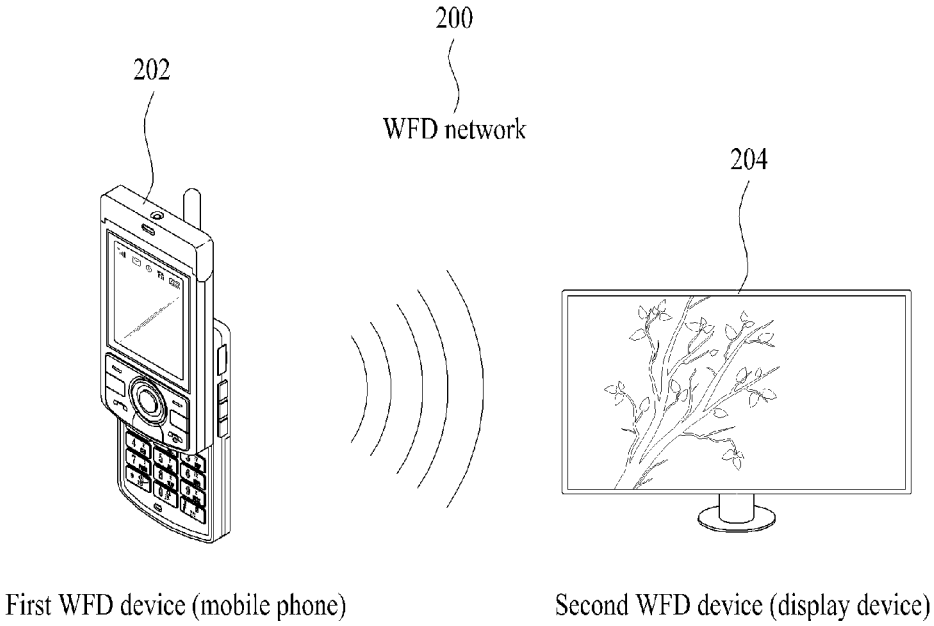

200
202
WFD network
204
First WFD device (mobile phone)
Second WFD device (display device)

FIG. 3

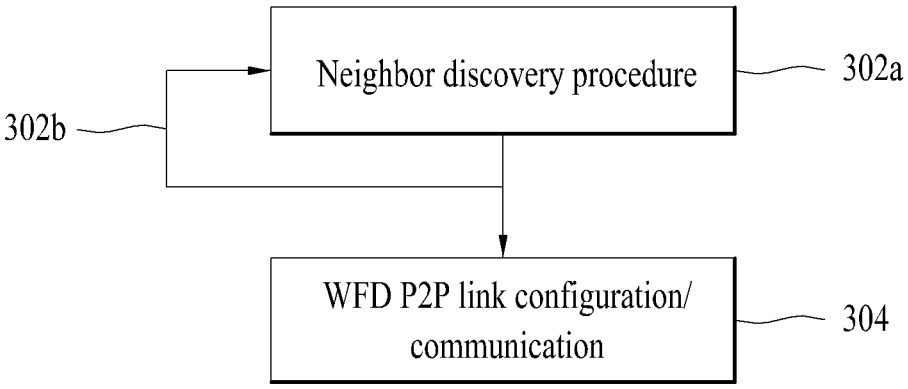

Neighbor discovery procedure
302a
302b
WFD P2P link configuration/
communication
304

FIG. 4

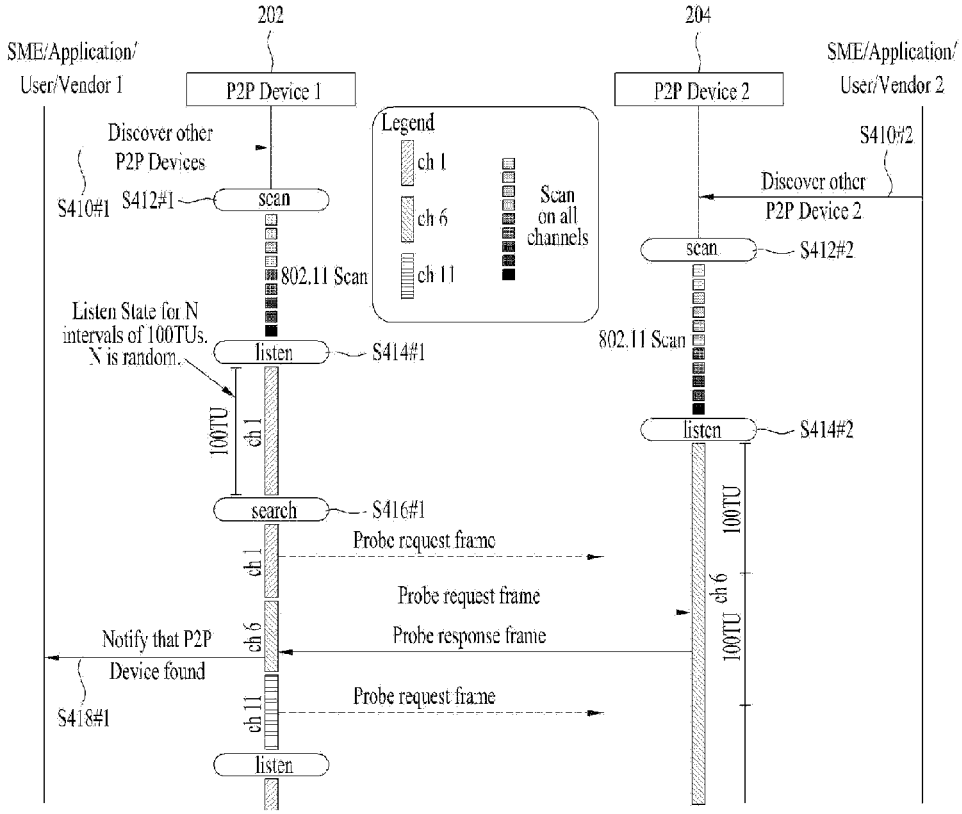

202
204
SME/Application/
User/Vendor 1
P2P Device 1
P2P Device 2
SME/Application/
User/Vendor 2
Legend
ch 1
ch 6
ch 11
Scan on all channels
Discover other P2P Devices
S410#1
S412#1
scan
802.11 Scan
S410#2
Discover other P2P Device 2
scan
S412#2
802.11 Scan
Listen State for N intervals of 100TUs. X is random.
listen
S414#1
100TU
ch 1
listen
S414#2
search
S416#1
Probe request frame
ch 1
Probe request frame
ch 6
Probe response frame
100TU
ch 6
100TU
Notify that P2P Device found
S418#1
ch 11
Probe request frame
listen

FIG. 5

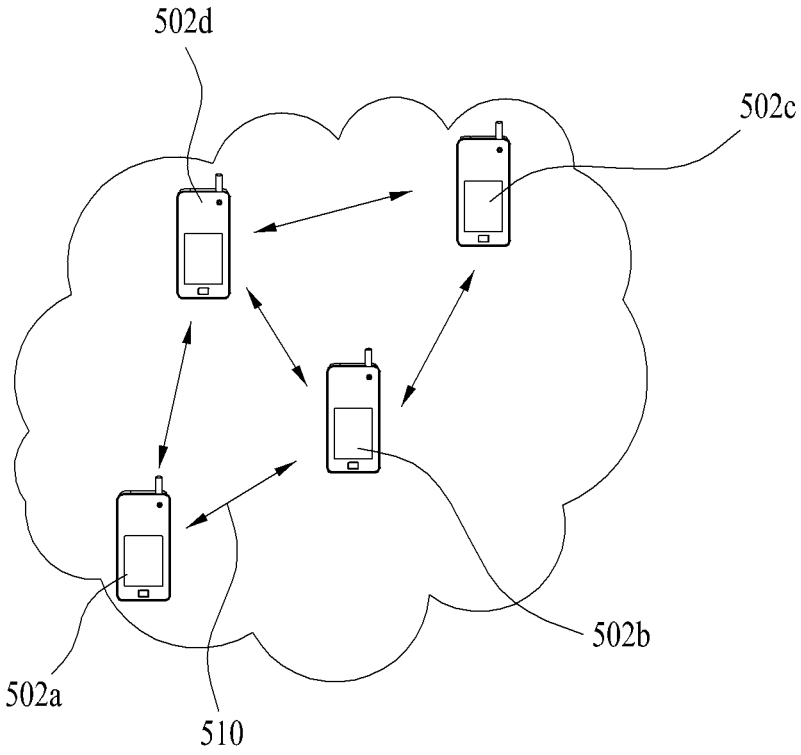


FIG. 6

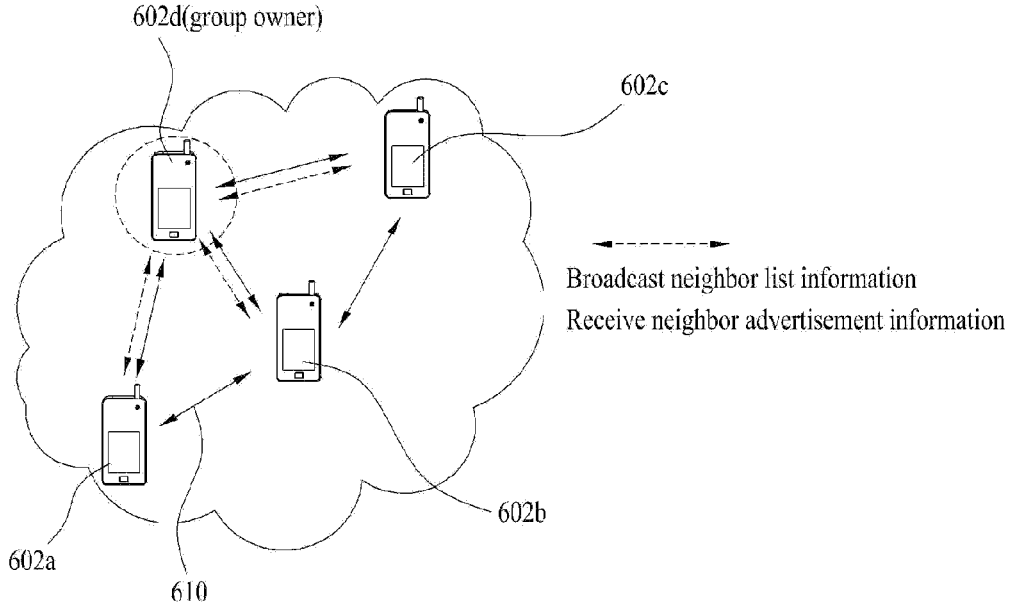

602d(group owner)
602c
Broadcast neighbor list information
Receive neighbor advertisement information
602b
602a
610

FIG. 7

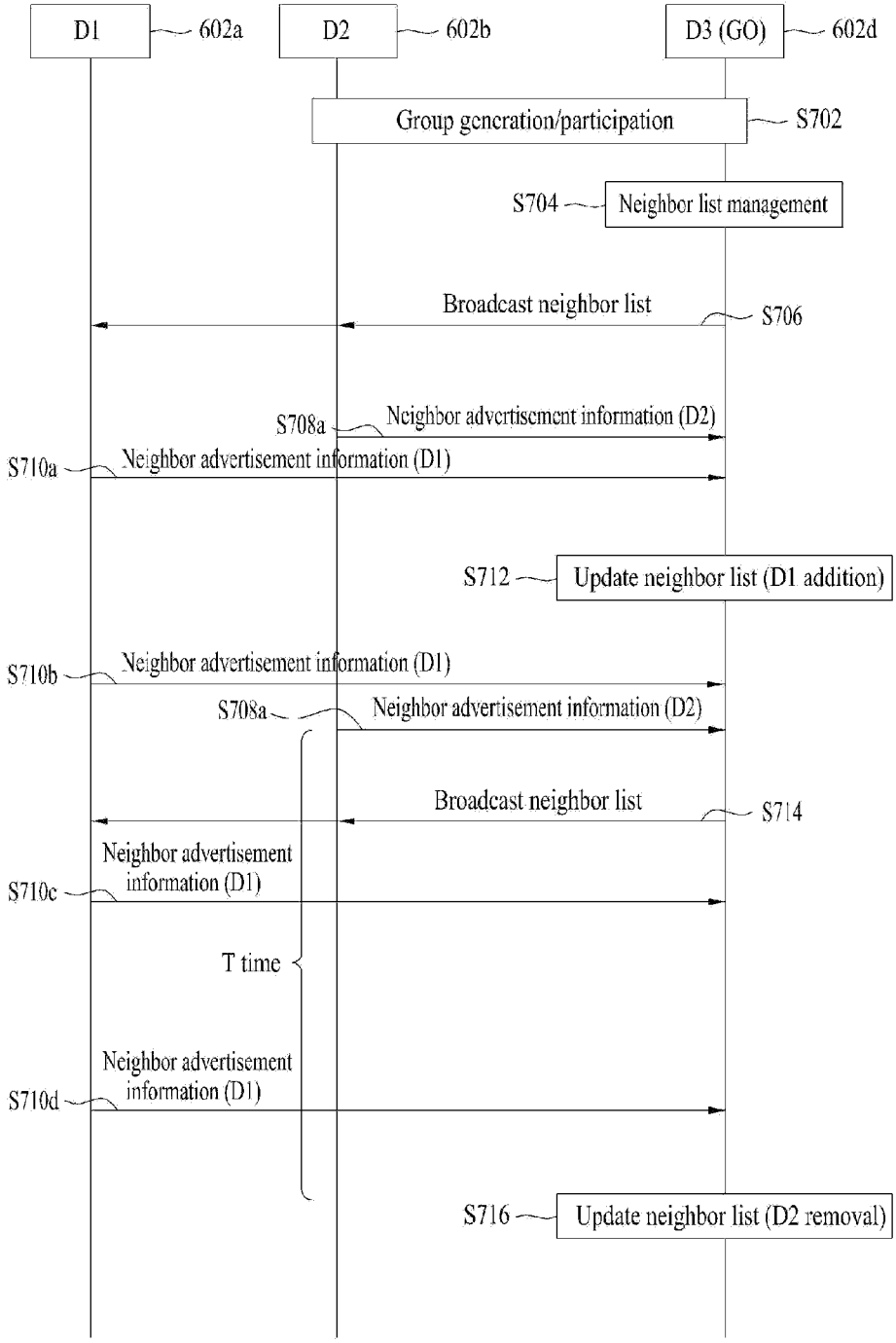

D1
602a
D2
602b
D3 (GO)
602d
Group generation/participation
S702
S704
Neighbor list management
Broadcast neighbor list
S706
S708a
Neighbor advertisement information (D2)
S710a
Neighbor advertisement information (D1)
S712
Update neighbor list (D1 addition)
S710b
Neighbor advertisement information (D1)
S708a
Neighbor advertisement information (D2)
Broadcast neighbor list
S714
Neighbor advertisement information (D1)
S710c
T time
Neighbor advertisement information (D1)
S710d
S716
Update neighbor list (D2 removal)

FIG. 8

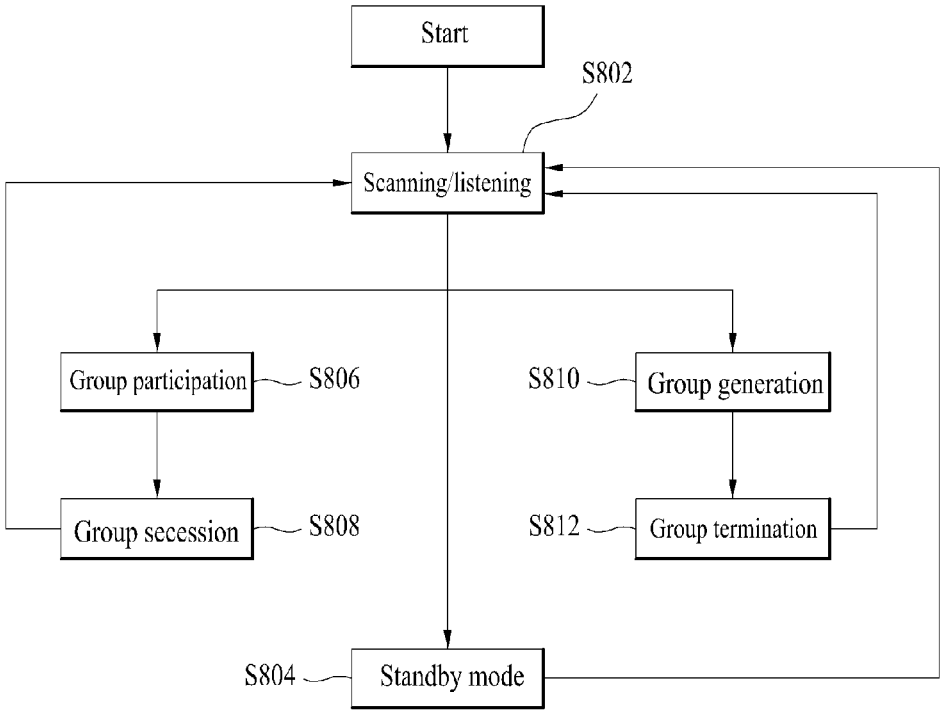
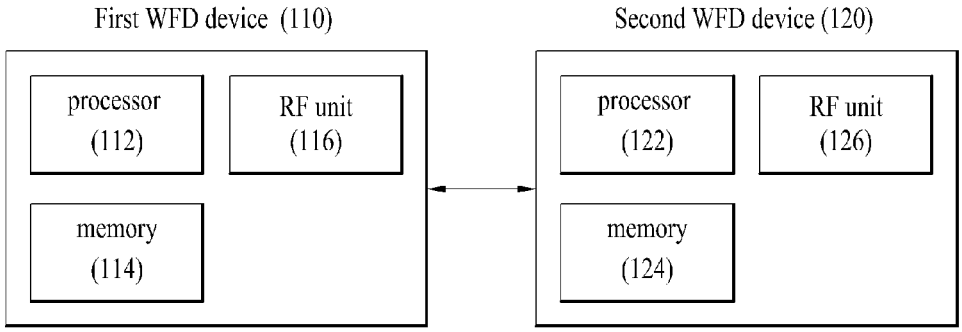

Start
S802
Scanning/listening
Group participation
S806
S810
Group generation
Group secession
S808
S812
Group termination
S804
Standby mode

FIG. 9


First WFD device (110)
processor (112)
RF unit (116)
memory (114)
Second WFD device (120)
processor (122)
RF unit (126)
memory (124)

METHOD AND DEVICE FOR DISCOVERING NEIGHBORS FOR WIRELESS FIDELITY DIRECT (WFD) PEER TO PEER (P2P) COMMUNICATION

TECHNICAL FIELD

[0001] The present invention relates to a method and apparatus for performing Wireless Fidelity Direct (WFD) Peer to Peer (P2P) communication in a wireless communication system, and more particularly to a method and apparatus for discovering a neighbor for WFD P2P communication.

BACKGROUND ART

[0002] Wireless communication systems have been widely used to provide various kinds of communication services such as voice or data services. Generally, a wireless communication system is a multiple access system that can communicate with multiple users by sharing available system resources (bandwidth, transmission (Tx) power, and the like). A variety of multiple access systems can be used. For example, a Code Division Multiple Access (CDMA) system, a Frequency Division Multiple Access (FDMA) system, a Time Division Multiple Access (TDMA) system, an Orthogonal Frequency Division Multiple Access (OFDMA) system, a Single Carrier Frequency-Division Multiple Access (SC-FDMA) system, and the like.

[0003] Standards for Wireless Local Area Network (WLAN) technology have been developed as Institute of Electrical and Electronics Engineers (IEEE) 802.11 specifications. IEEE 802.11b may provide a maximum transfer rate of 11 Mbps, and IEEE 802.11a may provide a maximum transfer rate of 54 Mbps. IEEE 802.11g may use Orthogonal Frequency Division Multiplexing (OFDM) at 2.4 GHz, and provide a transfer rate of 54 Mbps. IEEE 802.11n may use Multiple Input Multiple Output (MIMO)-OFDM, and provide a transfer rate of 300 Mbps to four spatial streams. IEEE 802.11a and 802.11b use an unlicensed band at 2.4 GHz or 5 GHz. IEEE 802.11b provides a transmission rate of 11 Mbps and IEEE 802.11a provides a transmission rate of 54 Mbps. IEEE 802.11g applies Orthogonal Frequency-Division Multiplexing (OFDM) at 2.4 GHz to provide a transmission rate of 54 Mbps. IEEE 802.11n may use Multiple Input Multiple Output (MIMO)-OFDM, and provide a transfer rate of 300 Mbps. IEEE 802.11n may support a channel bandwidth up to 40 MHz to provide a transfer rate of 600 Mbps. IEEE 802.11p is a standard for supporting Wireless Access in Vehicular Environment (WAVE). For example, IEEE 802.11p provides improvement matters needed for supporting Intelligent Transportation Systems (ITS). IEEE 802.11ai is a standard for supporting fast initial link setup of an IEEE 802.11 station (STA).

DISCLOSURE

Technical Problem

[0004] An object of the present invention is to provide a method and apparatus for efficiently performing WFD P2P communication. Another object of the present invention is to provide a method and apparatus for efficiently discovering neighbors for WFD P2P communication.

[0005] It is to be understood that technical objects to be achieved by the present invention are not limited to the aforementioned technical objects and other technical objects which are not mentioned herein will be apparent from the following description to one of ordinary skill in the art to which the present invention pertains.

Technical Solution

[0006] In an aspect of the present invention, a method for performing a neighbor discovery procedure for wireless fidelity direct (WFD) peer to peer (P2P) communication is provided, in which the method comprises: determining, by a first WFD P2P device, if a participatable WFD P2P group exists or not; if the participatable WFD P2P group exists, allowing performing, by the first WFD P2P device, an operation for participating in the participatable WFD P2P group; and if the participatable WFD P2P group does not exist, performing, by the first WFD P2P device, an operation for generating a new WFD P2P group or entering a sleep mode, wherein the operation for participating in the participatable WFD P2P group includes: receiving neighbor list information about second WFD P2P device(s) in the WFD P2P group from a specific WFD P2P device managing the WFD P2P group; and periodically transmitting neighbor advertisement information about the first WFD P2P device to the specific WFD P2P device after reception of the neighbor list information.

[0007] In another aspect of the present invention, a first wireless fidelity direct peer to peer (WFD P2P) device configured to perform a neighbor discovery procedure for WFD P2P communication is provided, in which the first WFD P2P device comprises: a radio frequency (RF) unit; and a processor, wherein the processor determines if a participatable WFD P2P group exists or not, if the participatable WFD P2P group exists, performs an operation for participating in the participatable WFD P2P group, and if the participatable WFD P2P group does not exist, and perform an operation for generating a new WFD P2P group or entering a sleep mode, wherein the operation for participating in the participatable WFD P2P group includes: receiving neighbor list information about second WFD P2P device(s) in the WFD P2P group from a specific WFD P2P device managing the WFD P2P group; and periodically transmitting neighbor advertisement information about the first WFD P2P device to the specific WFD P2P device after reception of the neighbor list information.

[0008] A transmission period of the neighbor advertisement information may be adaptively configured in consideration of at least one of (1) mobility of the first WFD P2P device, (2) power level of the first WFD P2P device, (3) a level of service provision intent of the first WFD P2P device scheduled to receive or provide a service, and (4) the number of services to be received by the first P2P device.

[0009] The neighbor list information may include at least one of WFD P2P device ID information, mobility associated information, power information, WFD P2P device associated information, and information for pre-association with a WFD P2P device.

[0010] The generation of the new WFD P2P group may include: broadcasting neighbor list information having information regarding the fist WFD P2P device; receiving neighbor advertisement information about the corresponding WFD P2P device from third WFD P2P device(s) broadcasting the neighbor list information; and updating the neighbor list information using the neighbor advertisement information.

[0011] If neighbor advertisement information is not received from at least one WFD P2P device of the third WFD

P2P device(s) for a predetermined time or more, information about the at least one WFD P2P device may be removed from the neighbor list information.

Advantageous Effects

[0012] As is apparent from the above description, the embodiments of the present invention can efficiently perform WFD P2P communication in a wireless communication system. In more detail, the embodiments can efficiently discover a neighbor for WFD P2P communication.

[0013] It will be appreciated by persons skilled in the art that the effects that can be achieved with the present invention are not limited to what has been particularly described hereinabove and other advantages of the present invention will be more clearly understood from the following detailed description taken in conjunction with the accompanying drawings.

DESCRIPTION OF DRAWINGS

[0014] The accompanying drawings, which are included to provide a further understanding of the invention, illustrate embodiments of the invention and together with the description serve to explain the principle of the invention.

[0015] FIG. **1***a* exemplarily shows an IEEE 802.11 system according to one embodiment of the present invention.

[0016] FIG. **1***b* is a block diagram illustrating a communication system including access devices and wireless UE devices.

[0017] FIG. **2** is a conceptual diagram illustrating a Wi-Fi Direct (WFD) network.

[0018] FIG. **3** is a flowchart illustrating a method for constructing a WFD network.

[0019] FIG. **4** is a conceptual diagram illustrating a neighbor discovery process.

[0020] FIG. **5** shows an exemplary WFD network.

[0021] FIGS. **6** and **7** show exemplary neighbor discovery processes according to the present invention.

[0022] FIG. **8** is a flowchart illustrating a status diagram of the neighbor discovery process according to the present invention.

[0023] FIG. **9** is a block diagram illustrating a WFD P2P device applicable to the present invention.

BEST MODE

[0024] The following embodiments of the present invention can be applied to a variety of wireless access technologies, for example, CDMA (Code Division Multiple Access), FDMA (Frequency Division Multiple Access), TDMA (Time Division Multiple Access), OFDMA (Orthogonal Frequency Division Multiple Access), SC-FDMA (Single Carrier Frequency Division Multiple Access), OFDM (Orthogonal Frequency Division Multiplexing), and the like. CDMA may be embodied through wireless (or radio) technology such as UTRA (Universal Terrestrial Radio Access) or CDMA2000. TDMA may be embodied through wireless (or radio) technology such as GSM (Global System for Mobile communications)/GPRS (General Packet Radio Service)/EDGE (Enhanced Data Rates for GSM Evolution). OFDMA may be embodied through wireless (or radio) technology such as IEEE 802.16 (WiMAX), IEEE 802-20, and E-UTRA (Evolved UTRA). OFDM may be implemented through wireless (or radio) technology such as IEEE 802.11.

[0025] For clarity, the following description focuses on IEEE 802.11 (Wi-Fi). However, technical features of the present invention are not limited thereto. For example, exemplary embodiments of the present invention are supported by standard documents disclosed for at least one of wireless access systems including an Institute of Electrical and Electronics Engineers (IEEE) 802 system, a 3^{rd} Generation Project Partnership (3GPP) system, a 3GPP Long Term Evolution (LTE) system, an LTE-Advanced (LTE-A) system, and a 3GPP2 system. In particular, the steps or parts, which are not described to clearly reveal the technical idea of the present invention, in the embodiments of the present invention may be supported by the above documents. All terminology used herein may be supported by at least one of the above-mentioned documents.

[0026] It should be noted that specific terms disclosed in the present invention are proposed for convenience of description and better understanding of the present invention, and the use of these specific terms may be changed to other formats within the technical scope or spirit of the present invention. In some instances, well-known structures and devices are omitted in order to avoid obscuring the concepts of the present invention and the important functions of the structures and devices are shown in block diagram form. The same reference numbers will be used throughout the drawings to refer to the same or like parts. The order of operations to be disclosed in the embodiments of the present invention may be changed. Some components or characteristics of any embodiment may also be included in other embodiments, or may be replaced with those of the other embodiments as necessary.

[0027] FIG. **1***a* exemplarily shows an IEEE 802.11 system according to one embodiment of the present invention.

[0028] The structure of the IEEE 802.11 system may include a plurality of components. A WLAN which supports transparent STA mobility for a higher layer may be provided by mutual operations of the components. A Basic Service Set (BSS) may correspond to a basic constituent block in an IEEE 802.11 LAN. In FIG. **1***a*, two BSSs (BSS**1** and BSS**2**) are shown and two STAs are included in each of the BSSs (i.e. STA**1** and STA**2** are included in BSS**1** and STA**3** and STA**4** are included in BSS**2**). In this case, STA may operate according to MAC (Medium Access Control)/PHY (Physical) rules. STA may include an Access Point (AP) STA (hereinafter referred to as "AP") and a non-AP STA. AP may provide network (e.g., WLAN) connection to a non-AP STA through a radio interface. AP may be implemented as a fixed type or a mobile type, and may include mobile wireless devices (e.g., a laptop computer, a smartphone, etc.) for providing a hot spot. The AP may correspond to a base station (BS), a Node-B, an evolved Node-B (eNB), a base transceiver system (BTS), a femto BS, etc. The non-AP STA may correspond to a handheld device, for example, a laptop computer, a PDA, a wireless modem, a smartphone, etc. In the following description, the non-AP STA may be referred to as a terminal, a Wireless Transmit/Receive Unit (WTRU), a User Equipment (UE), a Mobile Station (MS), a mobile terminal, or a Mobile Subscriber Station (MSS).

[0029] An ellipse indicating the BSS in FIG. **1***a* may be understood as a coverage area in which STAs included in the corresponding BSS maintain communication. This area may be referred to as a Basic Service Area (BSA). In the IEEE 802.11 LAN, the most basic type of BSS is an Independent BSS (IBSS). For example, the IBSS may have a minimum form consisting of only two STAs. The BSS (BSS**1** or BSS**2**) of FIG. **1***a*, which is the simplest form and in which other components are omitted, may correspond to a typical

example of the IBSS. Such configuration is possible when STAs can directly communicate with each other. Such a type of LAN is not prescheduled and may be configured when the LAN is necessary. This may be referred to as an ad-hoc network.

[0030] Memberships of an STA in the BSS may be dynamically changed when the STA is switched on or off or the STA enters or leaves the BSS region. The STA may use a synchronization process to join the BSS. To access all services of a BSS infrastructure, the STA should be associated with the BSS.

[0031] FIG. **1***b* is a block diagram illustrating a communication system **100** including access devices (e.g., AP STAs) (**102**A, **102**B, **102**C) and wireless UE devices (e.g., non-AP STAs).

[0032] Referring to FIG. **1***b*, the access devices (**102**A to **102**C) are connected to a switch **104** for providing connection to a Wide Area Network (WAN) **106** such as Internet. The access devices (**102**A to **102**C) may provide wireless connection to wireless communication devices contained in a coverage area (not shown) of the access devices through a time division multiplexing (TDM) network. Therefore, the access devices (**102**A to **102**C) may commonly provide the whole WLAN coverage region of the system **100**. For example, a wireless device **108** may be present in a coverage region of the access devices (**102**A, **102**B), as represented by a box denoted by a solid line. Therefore, the wireless device **108** may receive beacons from respective access devices (**102**A, **102**B) as denoted by solid-lined arrow marks (**110**A, **110**B). If the wireless device **108** roams from a solid-lined box to a dotted-lined box, the wireless device **108** enters a coverage region of the access device **102**C, and moves out of a coverage region of the access device **102**A. Accordingly, the wireless device **108** may receive beacons from the access devices (**102**B, **102**C) as denoted by dotted-lined arrow marks (**112**A, **112**B).

[0033] When the wireless device **108** roams in the whole WLAN coverage region provided from the system **100**, the wireless device **108** may determine which access device provides the best connection to the current wireless device **108**. For example, the wireless device **108** may repeatedly scan beacons of neighbor access devices, and may measure signal strength (e.g., power) associated with each beacon. Accordingly, the wireless device **109** may be connected to an access device for providing optimum network connection on the basis of maximum beacon signal strength. The wireless device **108** may use other references associated with optimum connection. For example, the optimum connection may be associated with many more preferable services (e.g., content, data rate, and the like).

[0034] FIG. **2** is a conceptual diagram illustrating a Wi-Fi Direct (WFD) network. The WFD network can enable the Wi-Fi devices not to participate in a home network, an office network, a hot-spot network, and performs Device to Device (D2D) (or Peer to Peer: P2P) communication, and has been proposed by Wi-Fi Alliance. Hereinafter, WFD based communication is referred to as WFDD2D communication (simply, D2D communication) or WFDP2P communication (simply, P2P communication). In addition, the WFDP2P execution device will hereinafter be referred to as a WFDP2P device (simply a P2P device).

[0035] Referring to FIG. **2**, the WFD network **200** may include at least one Wi-Fi device configured to include a first WFD device **202** and a second WFD device **204**. The WFD device may include Wi-Fi supporting devices, for example, a display device, a printer, a digital camera, a projector, a smartphone, etc. In addition, the WFD device may include a non-AP STA and an APSTA. In this example, the first WFD device **202** is a smartphone, and a second WFD device **204** display device. The WFD devices of the WFD network may be directly interconnected. In more detail, P2P communication may indicate that a signal transmission path between two WFD devices is directly configured in the corresponding WFD devices without passing through a third device (e.g., AP) or a legacy network (e.g., a network coupled to WLAN through an AP). In this case, a signal transmission path directly configured between two WFD devices may be limited to a data transmission path. For example, P2P communication may indicate that a plurality of non-STAs transmits data (e.g., voice, image, text information, etc.) without passing through the AP. A signal transmission path for control information (e.g., resource allocation information for P2P configuration, wireless device ID information, etc.) may be directly configured between WFD devices (e.g., non-AP STA to non-AP STA, non-AP STA to AP), may be configured between two WFD devices (e.g., non-AP to non-AP STA) via the AP, or may be configured between the AP and the corresponding WFD device (e.g., AP to non-AP STA #**1**, AP to non-AP STA #**2**).

[0036] FIG. **3** is a flowchart illustrating a method for constructing a WFD network.

[0037] Referring to FIG. **3**, the WFD network construction process may be largely classified into two processes. A first process is a neighbor discovery (ND) procedure in step S**302***a*. A second process is a P2P link configuration and communication process in step S**304**. Through the neighbor discovery process, the WFD device (e.g., **202** of FIG. **2**) searches for another neighbor WFD device (e.g., **204** of FIG. **2**) contained in (its own radio) coverage, and may obtain information of association (e.g., pre-association) with the corresponding WFD device. In this case, the pre-association may indicate a second layer pre-association in a radio protocol. For example, information needed for the pre-association may include ID information of the neighbor WFD device. The neighbor discovery process may be carried out per available radio channel in step S**302***b*. Thereafter, the WFD device **202** may perform WFDP2P link configuration/communication with another WFD device **204**. For example, after the WFD device **202** is connected to a peripheral WFD device **204**, it is determined whether the corresponding WFD device **204** is a WFD device incapable of satisfying service requirements of a user. For this purpose, after the WFD device **202** is connected to the peripheral WFD device **204** and the second layer pre-association, the WFD device **202** can explore the corresponding WFD device **204**. If the corresponding WFD device **204** does not satisfy service requirements of the user, the WFD device **202** may sever association of the second layer configured in the corresponding WFD device **204**, and may configure the second layer association with another WFD device. In contrast, if the corresponding WFD device **204** satisfies the user service requirements, two WFD devices (**202**, **204**) can transmit and receive signals through the P2P link.

[0038] The neighbor discovery process is shown in FIG. **4**. FIG. **4** exemplarily shows the operations between one WFD device **202** and the other WFD device **204** shown in FIG. **3**.

[0039] Referring to FIG. **4**, the neighbor discovery process of FIG. **3** may be initiated by indication of station management entity (SME)/application/user/vendor in step S**410**. The scanning step S**412** may include the operation for scanning all

available RF channels according to 802.11 schemes. Through the above-mentioned operation, the P2P device can confirm the best operation channel. The search steps (**S414**~**S416**) may include a listening mode **S414** and a searching mode **S416**. The P2P device may alternately repeat the listening mode **S414** and the searching mode **S416**. The P2P devices (**202**, **204**) may perform active searching using a probe request frame in the searching mode **S416**. For rapid searching, the searching range may be limited to social channels denoted by Channels #**1**, #**6**, #**11** (2412, 2437, 2462 MHz). In addition, the P2P devices (**202**, **204**) may select only one channel from among three social channels in the listening mode **S414**, and maintain a reception status. In this case, if the other P2P device (e.g., **202**) receives the probe request frame in the searching mode, the P2P device (e.g., **204**) generates a probe response frame in response to the received probe request frame. A time of the listening mode **S414** may be given at random (e.g., 100, 200, 300 time unit (TU)). The P2P device continuously repeats the search mode and the reception mode so that it reaches a common channel. After the P2P device discovers another P2P device, the P2P device may discover/exchange a device type, a manufacturer, or a familiar device name by using the probe request frame and the probe response frame such that the P2P device can be selectively coupled to the corresponding P2P device. If the P2P device discovers the peripheral P2P device and obtains necessary information through the neighbor discovery process, the P2P device (e.g., **202**) may inform SME/application/UE/vendor of the P2P device discovery in step **S418**.

[0040] Presently, P2P may be mainly used for semi-static communication such as remote printing, photo sharing, etc. However, due to generalization of Wi-Fi devices and location based services, P2P availability is gradually increased. For example, wireless devices registered in social chatting (e.g., Social Network Service (SNS)) can recognize radio devices located in a neighboring region on the basis of the location based service, and can transmit and receive information in the neighboring region on the basis of the location based service. It is expected that the P2P device will be actively used in location-based advertisement provision, location-based news broadcasting, and game interaction between wireless devices. For convenience of description, such P2P application will hereinafter be referred to as new P2P application.

[0041] FIG. **5** shows the WFD network aspects for use in the case in which new P2P application (e.g., social chatting, location-based service provision, game interaction, etc.) is applied. Referring to FIG. **5**, a plurality of P2P devices (**502***a* to **502***d*) performs P2P communication **510** in the WFD network, P2P device(s) constructing the WFD network may be changed at any time due to movement of the P2P device(s), and a new WFD network may be dynamically generated or deleted within a short time. As described above, characteristics of the new P2P application indicate that P2P communication can be dynamically performed and terminated within a short time among a plurality of P2P devices in the dense network environment.

[0042] However, since the legacy P2P mechanism does not consider dynamic P2P communication among a plurality of P2P devices, it is impossible for the legacy P2P mechanism to efficiently cope with the new P2P application. For example, the legacy WFD neighbor discovery process shown in FIGS. **3** to **4** is inappropriate for new P2P application. As shown in FIG. **4**, the neighbor discovery process may include the searching mode and the listening mode and be independently configured in each P2P device, and this information is not shared among the P2P devices. Accordingly, for P2P communication, the P2P devices repeat the searching mode/the listening mode using the on-demand/blind scheme, and may reach a mutual common channel. The neighbor discovery process using the blind scheme can reduce unnecessary signaling overhead in the case in which there is a small number of P2P devices participating in the WFD network, resulting in increased resource efficiency. However, if the number of P2P devices participating in the WFD network is increased up to a predetermined number, the following problems may occur. In more detail, according to the legacy scheme, (1) a long-time latency until neighbor discovery is completed, (2) inefficiency (high overhead) of neighbor discovery in the dense network, and (3) high communication overhead for connection (or association) configuration.

[0043] In order to solve the above-mentioned problems, the present invention provides a method for dynamically permitting the neighbor discovery process. For convenience of description, the above-mentioned scheme of the present invention is referred to as an automatic neighbor discovery scheme. The legacy scheme of FIG. **4** is referred to as the On-Demand neighbor discovery scheme.

[0044] FIG. **6** is a conceptual diagram illustrating the neighbor discovery process according to the present invention. The basic situation/assumption of FIG. **6** is identical to those of FIG. **5**.

[0045] Unlike the concept of FIG. **6**, the neighbor discovery process of FIG. **6** can provide a group owner (Go) **602***d* to the WFD network. In this case, the group owner may broadcast neighbor list information to the peripheral P2P device (within the operation frequency) as denoted by a dotted arrow, and may receive neighbor advertisement information from the P2P device that wants to participate in the P2P group. In this case, the neighbor list information may include, for example, P2P device ID information (e.g., device ID, device nickname, etc.), mobility associated information (e.g., moving speed), power information, P2P service associated information (e.g., a service category, a social group, etc.), and information regarding pre-association with the corresponding P2P device. The neighbor list information may be broadcast by a request of the P2P device, or may be periodically broadcast by the request of the P2P device. The neighbor list information may be transmitted through a beacon. The group owner **602***d* may be pre-configured (e.g., AP), any one of the P2P devices (e.g., **602***a* to **602***d*) may be selected as a group owner by a network in response to a situation, or any one of the P2P devices (e.g., **602***a* to **602***d*) may autonomously serve as a group owner according to a situation. In addition, the number of P2P devices capable of being managed by the group owner **602***d* may be limited by WFD capability/coverage/available power. For this purpose, the neighbor list information may further include available group information (e.g., 1 bit information). For example, assuming that the number of P2P devices capable of being managed by the group owner **602***d* is set to N and N P2P devices participate in the group, the group owner **602***d* may assign a specific value (e.g., 1) indicating non-permission of group participation to the available group information.

[0046] The neighbor advertisement information may be used for the P2P devices (**602***a* to **602***c*) to inform the group owner **602***d* of an intention of participating in the group. In addition, the neighbor advertisement information may include information needed for the group owner **602***d* to

generate/manage the neighbor list, for example, P2P device ID information (e.g., device ID, device nickname, etc.), mobility associated information (e.g., moving speed), power information, P2P service associated information (e.g., a service category, a social group, etc.). Transmission of neighbor advertisement information may be initiated by reception of the neighbor list information, or may be initiated when P2P group participation is needed irrespective of reception of the neighbor list information.

[0047] The neighbor list information may be periodically transmitted. However, the neighbor list may be periodically transmitted only when the P2P devices (**602***a* to **602***c*) recognize the presence of the group owner **602***d* or only when the P2P devices (**602***a* to **602***c*) recognize that they do not escape from the WFD network. For example, if the P2P devices (**602***a* to **602***c*) do not receive the neighbor list information for a predetermined time or more, the P2P devices (**602***a* to **602***c*) may stop transmission of the neighbor advertisement information. In this case, each of the P2P devices (**602***a* to **602***c*) may await until receiving new neighbor list information, or may serve as a group owner (e.g., neighbor list information generation/management/broadcasting).

[0048] The period/frequency for transmission of the neighbor advertisement information may be independently configured per P2P device. For example, the transmission period/frequency of the neighbor advertisement information may be decided in consideration of at least one of (1) mobility of the P2P device (e.g., moving speed), (2) power level of the P2P device, (3) intent (or a service interest level) for service provision, and (4) the number of services to be received by the first P2P device. In more detail, the higher the mobility (e.g., moving speed) of the P2P device, the longer/lower the transmission period/frequency of the neighbor advertisement information. In contrast, the lower the P2P device mobility, the shorter/higher the transmission period/frequency of the neighbor advertisement information. In addition, the higher a power level of the P2P device, the shorter/higher the period/frequency of the neighbor advertisement information. In contrast, the lower the power level of the P2P device, the longer/lower the transmission period/frequency of the neighbor advertisement information. In addition, the higher the service interest of the P2P device, the shorter/higher the transmission period/frequency of neighbor advertisement information. In contrast, the lower the service interest of the P2P device, the shorter/lower the transmission period/frequency of the neighbor advertisement information.

[0049] The P2P devices (**602***a* to **602***d*) can recognize information regarding the presence/ID information/pre-association of the device capable of performing P2P communication on the basis of the neighbor list information, such that the P2P devices (**602***a* to **602***d*) can obtain information regarding all the associated P2P devices if only the P2P group owner is found, without performing the neighbor discovery process for all the P2P devices. After acquiring the neighbor list information, the P2P device (e.g., **602***a*) may perform P2P communication **610** with the corresponding P2P device according to a desired service category or the like.

[0050] In the meantime, if the group owner **602***d* does not receive neighbor advertisement information for a predetermined time (e.g., T time) from the P2P device in the neighbor list, the corresponding P2P device may be removed from the neighbor list. Thereafter, the group owner **602***d* may periodically broadcast the updated neighbor list. The above T time may be independently given to each P2P device. In a similar way to the period/frequency of the neighbor advertisement message, the T time may be decided in consideration of at least one of (1) mobility of the P2P device (e.g., moving speed), (2) power level of the P2P device, (3) intent (or a service interest level) for service provision, and (4) the number of services to be received by the first P2P device. The T time may be set to a specific time corresponding to an M times the neighbor advertisement period (where M is an integer higher than 1).

[0051] For reference, the P2P group and the P2P group owner have been defined in the legacy P2P mechanism. However, according to the legacy P2P mechanism, the P2P group enables the P2P group owner to serve as an AP, and enables the P2P client to serve as the STA. In this regard, the legacy P2P group is similar to a BSS of FIG. **1**, but is irrelevant to that the P2P group owner manages/broadcasts the neighbor list and the P2P client transmits the neighbor advertisement information.

[0052] FIG. **7** is a flowchart illustrating an automatic neighbor discovery process according to the present invention. The basic situation/assumption is similar to those of FIG. **6**. For convenience of description, although FIG. **7** shows an exemplary case in which three P2P devices participate in the P2P group, it should be noted that four or more P2P devices can also participate in the P2P group without departing from the scope or spirit of the present invention.

[0053] Referring to FIG. **7**, a group is generated between D**2** (e.g., **602***b* of FIG. **6**) and D**3** (e.g., **602***d* of FIG. **6**), and D**2** may participate in the group in step S**702**. In this case, it is assumed that the group owner (GO) is set to D**3** and the group member is set to D**2**. Since D**2** participates in the group, the group owner D**3** manages/updates the neighbor list, and broadcasts the updated neighbor list according to the period in step S**706**. D**1** (e.g., **602***a* of FIG. **6**) receives the neighbor list, such that it recognizes the presence of a group owner and periodically transmits the neighbor advertisement information to the group owner in steps S**710***a* to S**710***d*. Similarly, D**2** may periodically transmit its own neighbor advertisement information to the group owner in steps S**708***a* to S**708***d*. After the group owner receives neighbor advertisement information of D**1**/D**2**, it adds D**1**-associated information to the neighbor list in step S**712** and broadcasts the updated neighbor list in accordance with a period in step S**714**. The period/frequency of neighbor advertisement information broadcast by D**1** and D**2** may be decided per P2P device in consideration of at least one of (1) mobility of the P2P device (e.g., moving speed), (2) power level of the P2P device, (3) intent (or a service interest level) for service provision, and (4) the number of services to be received by the first P2P device.

[0054] Meanwhile, this example assumes that D**2** leaves from a group coverage due to the movement of D**2**. Due to the movement of D**2**, D**2** may not receive neighbor list information from the group owner for a predetermined time, and may recognize that D**2** has left from the group. Accordingly, D**2** may not provide the neighbor advertisement information to the group owner D**3** anymore. In contrast, from the viewpoint of the group owner, since signal strength decreases due to D**2**'s out of coverage or neighbor advertisement information is not transmitted from D**2**, no neighbor advertisement information may be received from the D**2** for a predetermined time (e.g., T time). In this case, the group owner can determine that D**2** has left from the group and can remove D**2** associated information from the neighbor list in step S**716**.

[0055] FIG. **8** is a flowchart illustrating a status diagram of the neighbor discovery process according to the present invention. The basic operations of FIG. **8** are identical or similar to those of FIGS. **6** and **7**. Referring to FIG. **8**, the P2P device (e.g., **602***a* of FIG. **6**) performs the scanning/listening operations of the available RF channel in step S**801**. If the group owner is found in the corresponding RF channel and the group owner has the capability of accommodating additional member(s), the P2P device may participate in the corresponding group in step S**806** or secede from the corresponding group in step S**808**. As a condition for group participation, it can be considered whether the corresponding group owner is managing the neighbor P2P interested by the P2P device. During secession from the group, the P2P device may perform again the scanning/listening process in step S**802**, or may defer the scanning/listening process as necessary.

[0056] In the meantime, if the P2P device does not participate in the group at a corresponding RF channel, the P2P device may self-generate a group, and may operate as a group owner in step S**810**. Cases that the P2P device cannot participate in the group includes: the legacy group/group owner may not exist, or the group exists but the group owner cannot accommodate the additional member. In addition, the exemplary case in which the P2P device operates as the group owner may be limited to a case in which the corresponding P2P device is pre-configured to serve as the group owner or a case in which the corresponding P2P device has enough power and stability to generate/maintain a necessary group. If P2P communication is completed, the P2P device terminates the group in step S**812**.

[0057] On the other hand, if group participation is impossible or group generation is also impossible, the P2P device enters the standby mode (e.g., sleep mode) in step S**804**.

[0058] In the shown status diagram, status modification associated with a group (e.g., group secession, group termination, etc.) may occur by movement, power limitation, etc. of the P2P device/group owner.

[0059] For convenience of description, although the above described embodiment has been disclosed on the basis of the automatic neighbor discovery process (See FIGS. **6** to **8**), the automatic neighbor discovery process according to the present invention may also be used along with the legacy on-demand neighbor discovery process (See FIG. **4**). For example, the automatic neighbor discovery process has priority so that the automatic neighbor discovery process is first carried out. If there is no P2P group capable of participating in the group, the legacy on-demand neighbor discovery process can be performed. In addition, the automatic neighbor discovery process of the present invention and the legacy on-demand neighbor discovery process can be selectively used according to configuration information.

[0060] FIG. **9** is a block diagram illustrating a WFD P2P device applicable to the present invention.

[0061] Referring to FIG. **9**, the WFD network includes a first WFD device **110** and a second WFD device **120**. The first WFD device **110** includes a processor **112**, a memory **114**, and a radio frequency (RF) unit **116**. The second WFD device **112** may be constructed to implement the procedures and/or methods disclosed in the embodiments of the present invention. The memory **114** may be connected to a processor **112**, and store various information related to operations of the processor **112**. The RF unit **116** is connected to the processor **112**, and transmits and/or receives RF signals. The second WFD device **120** includes a processor **122**, a memory **124**, and an RF unit **126**. The processor **122** may be constructed to implement the procedures and/or methods disclosed in the embodiments of the present invention. The memory **124** may be connected to a processor **122**, and store various information related to operations of the processor **122**. The RF unit **126** is connected to the processor **122**, and transmits and/or receives RF signals. The first WFD device **110** and/or the second WFD device **120** may include a single antenna or multiple antennas.

[0062] The aforementioned embodiments are achieved by combination of structural elements and features of the present invention in a predetermined fashion. Each of the structural elements or features should be considered selectively unless specified otherwise. Each of the structural elements or features may be carried out without being combined with other structural elements or features. Also, some structural elements and/or features may be combined with one another to constitute the embodiments of the present invention. The order of operations described in the embodiments of the present invention may be changed. Some structural elements or features of one embodiment may be included in another embodiment, or may be replaced with corresponding structural elements or features of another embodiment. Moreover, it will be apparent that some claims referring to specific claims may be combined with other claims referring to claims other than the specific claims to constitute the embodiment or add new claims by means of amendment after the application is filed.

[0063] The above-described embodiments may be implemented by various means, for example, by hardware, firmware, software, or a combination thereof. In a hardware configuration, the method according to the embodiments of the present invention may be implemented by one or more Application Specific Integrated Circuits (ASICs), Digital Signal Processors (DSPs), Digital Signal Processing Devices (DSPDs), Programmable Logic Devices (PLDs), Field Programmable Gate Arrays (FPGAs), processors, controllers, microcontrollers, or microprocessors.

[0064] In a firmware or software configuration, the method according to the embodiments of the present invention may be implemented in the form of modules, procedures, functions, etc. performing the above-described functions or operations. Software code may be stored in a memory unit and executed by a processor. The memory unit may be located at the interior or exterior of the processor and may transmit and receive data to and from the processor via various known means.

[0065] The detailed description of the preferred embodiments of the present invention has been given to enable those skilled in the art to implement and practice the invention. Although the invention has been described with reference to the preferred embodiments, those skilled in the art will appreciate that various modifications and variations can be made in the present invention without departing from the spirit or scope of the invention described in the appended claims. Accordingly, the invention should not be limited to the specific embodiments described herein, but should be accorded the broadest scope consistent with the principles and novel features disclosed herein.

INDUSTRIAL APPLICABILITY

[0066] Exemplary embodiments of the present invention can be applied to a P2P communication device. In more

detail, the embodiments of the present invention can be applied to a WFD P2P communication device.

1. A method for performing a neighbor discovery procedure for wireless fidelity direct (WFD) peer to peer (P2P) communication, the method comprising:

determining, by a first WFD P2P device, if a participatable WFD P2P group exists or not;

if the participatable WFD P2P group exists, allowing performing, by the first WFD P2P device, an operation for participating in the participatable WFD P2P group; and

if the participatable WFD P2P group does not exist, performing, by the first WFD P2P device, an operation for generating a new WFD P2P group or entering a sleep mode,

wherein the operation for participating in the participatable WFD P2P group includes:

receiving neighbor list information about second WFD P2P device(s) in the WFD P2P group from a specific WFD P2P device managing the WFD P2P group; and

periodically transmitting neighbor advertisement information about the first WFD P2P device to the specific WFD P2P device after reception of the neighbor list information.

2. The method according to claim **1**, wherein a transmission period of the neighbor advertisement information is adaptively configured in consideration of at least one of (1) mobility of the first WFD P2P device, (2) power level of the first WFD P2P device, (3) a level of service provision intent of the first WFD P2P device scheduled to receive or provide a service, and (4) the number of services to be received by the first P2P device.

3. The method according to claim **1**, wherein the neighbor list information includes at least one of WFD P2P device ID information, mobility associated information, power information, WFD P2P device associated information, and information for pre-association with a WFD P2P device.

4. The method according to claim **1**, wherein the generation of the new WFD P2P group includes:

broadcasting neighbor list information having information regarding the fist WFD P2P device;

receiving neighbor advertisement information about the corresponding WFD P2P device from third WFD P2P device(s) after broadcasting the neighbor list information; and

updating the neighbor list information using the neighbor advertisement information.

5. The method according to claim **4**, wherein:

if neighbor advertisement information is not received from at least one WFD P2P device of the third WFD P2P device(s) for a predetermined time or more, information about the at least one WFD P2P device is removed from the neighbor list information.

6. A first wireless fidelity direct peer to peer (WFD P2P) device configured to perform a neighbor discovery procedure for WFD P2P communication, the first WFD P2P device comprising:

a radio frequency (RF) unit; and

a processor,

wherein the processor determines if a participatable WFD P2P group exists or not, if the participatable WFD P2P group exists, performs an operation for participating in the participatable WFD P2P group, and if the participatable WFD P2P group does not exist, and perform an operation for generating a new WFD P2P group or entering a sleep mode,

wherein the operation for participating in the participatable WFD P2P group includes:

receiving neighbor list information about second WFD P2P device(s) in the WFD P2P group from a specific WFD P2P device managing the WFD P2P group; and

periodically transmitting neighbor advertisement information about the first WFD P2P device to the specific WFD P2P device after reception of the neighbor list information.

7. The first WFD P2P device according to claim **6**, wherein a transmission period of the neighbor advertisement information is adaptively configured in consideration of at least one of (1) mobility of the first WFD P2P device, (2) power level of the first WFD P2P device, (3) a level of service provision intent of the first WFD P2P device scheduled to receive or provide a service, and (4) the number of services to be received by the first P2P device.

8. The first WFD P2P device according to claim **6**, wherein the neighbor list information includes at least one of WFD P2P device ID information, mobility associated information, power information, WFD P2P device associated information, and information for pre-association with a WFD P2P device.

9. The first WFD P2P device according to claim **6**, wherein the operation for generating the new WFD P2P group includes:

broadcasting neighbor list information having information regarding the fist WFD P2P device;

receiving neighbor advertisement information about the corresponding WFD P2P device from third WFD P2P device(s) after broadcasting the neighbor list information; and

updating the neighbor list information using the neighbor advertisement information.

10. The first WFD P2P device according to claim **9**, wherein:

if neighbor advertisement information is not received from at least one WFD P2P device of the third WFD P2P device(s) for a predetermined time or more, information about the at least one WFD P2P device is removed from the neighbor list information.

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